CHAPTER 6
CHINA'S ENERGY NEEDS AND STRATEGIES

*"**ENERGY.** The Commission shall evaluate and assess how China's large and growing economy will impact upon world energy supplies and the role the United States can play, including joint R&D and technological assistance, in influencing China's energy policy."* [P.L. 108–7, Division P, Sec. 2(c)(2)(C)]

KEY FINDINGS

- China is now the world's second largest energy consumer and third largest net oil importer, increasingly dependent on outside sources, and this dependency influences China's energy and national security policies. China has a growing sense of insecurity because of increased dependence on tanker-delivered Middle East oil via sea lanes, including the Straits of Malacca and Hormuz, controlled by the U.S. Navy.
- Reliable access to energy supplies is essential for China's continued rapid economic growth. Shortages are even now forcing China to ration electric power supply. This has slowed down the manufacturing sector and may eventually significantly slow down overall economic growth.
- China's approach to securing its imported petroleum supplies through bilateral arrangements is an impetus for nonmarket reciprocity deals with Iran, Sudan, and other states of concern, including arms sales and WMD-related technology transfers that pose security challenges to the United States.
- The United States can influence China's state-controlled energy policy through technical assistance and through diplomacy. The United States can provide technical assistance to China and participate in joint research and development (R&D) aimed at developing more efficient energy sources, including clean coal technology. Through diplomacy, the United States can promote fuller integration of the PRC into the international oil security system.
- China does not have a meaningful strategic petroleum reserve today, although it is planning to address this deficiency. It does not participate in multilateral market stabilizing organizations such as the International Energy Agency (IEA) and thus benefits from global stockpiles and coordination in world energy crises and speculator-driven price spikes without incurring the attendant costs.
- China's large and rapidly growing demand for oil is putting pressure on global oil supplies. This pressure is likely to increase in the future, with serious implications for U.S. oil prices and supplies and therefore U.S. economic security. China's share of world oil consumption is projected to increase from almost seven per-

cent today to more than nine percent by 2020, whereas U.S. oil consumption is projected to decrease slightly and remain at almost twenty-five percent.

OVERVIEW

China's economic trajectory has driven its expanding energy needs, which have now made it the world's second largest energy consumer behind the United States. Accompanying this growing energy demand has been a growing dependence on imported oil, with China now the world's second largest oil consumer and third largest oil importer.[1] These trends clearly demonstrate that China has become—and will continue to be—a major player in world energy markets.

These developments have several important implications for the United States. First, China's long-term impact on global energy supplies needs to be carefully analyzed, along with whether China's current approach to energy security is conducive to U. S. and other oil-importing countries' long-term energy strategies. Second, China's heavy reliance on coal as an energy source poses a tremendous challenge to both China and the world, as much of this consumption involves unwashed coal and has lead to a surge in air pollution and emissions of greenhouse gases. Lastly, to enhance its energy security, China has entered into energy deals with a number of countries of concern, including Iran and Sudan. These arrangements are troubling, especially to the extent they might involve political accommodations and sales or other transfers of weapons and military technologies to these nations. In sum, China's growing energy demands, particularly its increasing reliance on oil imports, pose economic, environmental, and geostrategic challenges to the United States.

Moreover, China's increasing energy demands pose challenges for China's economic growth. China's export-led growth, fueled by its manufacturing sector, is dependent on energy supplies. China is experiencing increasing electric power shortages. Coal provides around two thirds of China's energy needs, but due to corruption, inefficiencies, and infrastructure problems, China, which has the world's third largest coal reserves, must now import coal in addition to growing amounts of oil and gas. Today, nineteen of thirty-one provinces are rationing electricity, and some factories are limited to a four-day week. This could take five percentage points off the expected annual industrial growth rate and reduce foreign investment.[2]

Proper U.S. policy in this area is a complex calculation given conflicting dynamics. On the one hand, improved energy efficiency and bringing China into the international energy system could help manage oil prices and oil crises, mitigate environmental degradation, and potentially mitigate China's outreach to certain states of concern like Iran and Sudan (and any associated weapons proliferation involved). On the other hand, it will make China's industrial base more efficient, thereby enhancing China's manufacturing competitiveness with the United States and exacerbating the concerns raised in Chapter 1 and may reduce U.S. energy leverage in the event of any U.S.-China conflict.

On October 30, 2003, the Commission held a hearing in Washington on China's energy needs and strategies to evaluate the impact of China's energy demands on global supplies, U.S. security interests, and possible ways in which the United States can influence China's energy policy. The Commission heard from Energy Information Administration (EIA) Administrator Guy Caruso and from energy industry analysts regarding China's role in the supplier-consumer country dynamics of the global petroleum marketplace.

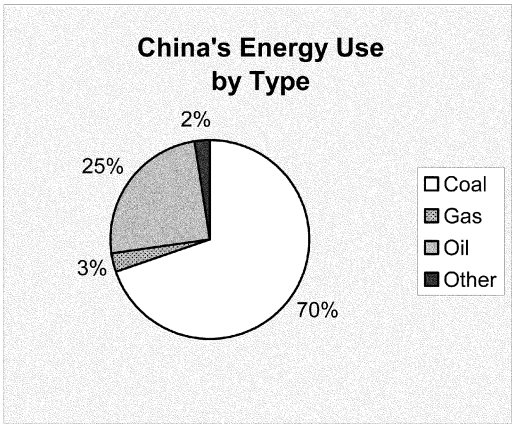
ANALYSIS AND FINDINGS

China's Energy Supply and Demand

China's energy development and policies are directed by the central and provincial governments. These governments "maintain their hold on the energy sector through ownership of energy companies, power to approve investments, and control over energy prices. China's energy policy is based upon a 'strategic' approach which eschews dependence on markets."[3] China's stated energy policy goals are a reduction of reliance on imports by further diversifying the types of energy used, broadening import sources, and raising the levels of technology used in energy production and consumption. In practice, the realization of China's goal of reduced dependency will probably be limited to coal. According to EIA Administrator Guy Caruso, China's actual long-term oil security goals are the development of a strategic petroleum reserve and to "become more involved in international multinational cooperation during oil emergencies."[4] Today, however, progress toward these goals is minimal. China's pragmatic approach is to deal with dependency while reducing vulnerability. The strategy includes leveraging bilateral relationships with key Middle Eastern and African suppliers, building stronger ties with Russia, establishing a market position in Central Asia, and continuing energy efficiency and alternate fuel R&D programs.

According to the EIA, China's total energy consumption will increase at an average annual rate of 3.8 percent through 2020. China's oil consumption was 5 million barrels per day (mb/d) in 2001 and is expected to be 10.9 in 2025, increasing at an average annual rate of 3.3 percent a year. By comparison, the United States is expected to go from 19.6 mb/d to 29.2 mb/d, a 1.7 percent average annual increase.[5] Figure 6.1 presents the type of energy China used, by percent, in 2003.

Figure 6.1 China's Energy Use by Type



Note: See appendix A, China's Energy Trends for further detail.
Source: Eric Ng, "Mainland Power Producers in a Quandary," *South China Morning Post* (Hong Kong), September 10, 2003.

Coal

China is the largest producer and consumer of coal in the world. It will remain China's dominant energy source for the foreseeable future.[6] After the United States and Russia, China has the world's third largest coal reserves (114 billion tons), and coal provides seventy percent of China's energy needs, including eighty-three percent of the electric power sector needs. These reserves are concentrated in China's north, northeast, and the central provinces, but energy requirements are primarily on the eastern seaboard. China is the world's second largest coal exporter. Yet, last year China imported almost eleven million tons of coal, primarily from Australia, the world's largest exporter, because it was cheaper to ship coal from Australia to China's eastern seaboard than to transport it from the Chinese interior by train. In addition, WTO entry has made access to foreign coal much easier for Chinese markets.[7] Sixty percent of China's coal is used in the electric power sector, increasing by fifty to sixty million tons each year. This increase is expected to be offset by the Three Gorges project, projected to produce the energy equivalent of fifty million tons of coal—or ten percent of current demand for electricity—when it is fully operational in 2009.[8] While China's coal imports are driven in part by delayed exploration, dropping capacity, closing of local and small mines, and infrastructure and transportation inadequacies, the main reason is the composition of China's coal reserves—its high grade coal is located in the interior, while the growth-generated power consumption is on the seaboard. While today China's growth-driven coal imports are not a geostrategic concern, future shifts in energy markets could increase pressure on supplies.

More pessimistic analyses hold that the vast bulk of China's reserves will be depleted in the near-to-medium term. Sixty-eight percent of China's coal-producing townships are in their autumn period, twelve percent are ailing, and only the remaining twenty percent have long-term production potential. Most analysts believe

that growth in demand will consistently exceed supply. According to *The Economist*, "China's considerable coal exports can be expected to fall, and it could become a net coal importer as soon as 2005. . . . [China] 'faces a risk of long-term coal and power shortages.'"[9]

Electric power drives China's manufacturing sector. China is developing twenty gigawatts of additional power generation capacity each year to sustain export-driven economic growth.[10] Clean Coal Technology (CCT) is not widely implemented in China's power industry. Many power plants are small or medium (less than three hundred megawatts in size), designed to burn low-quality (low thermal efficiency and polluting) coal. The results are high power generation costs, pollution, and insufficient generation capacity. Improving the efficiency of the coal sector could slow down the accelerating reliance on energy imports. But transportation infrastructure inadequacy, capital rationing, and water shortages restrict efforts to improve the quality of coal through greater use of coal-washing plants, as does lack of demand for better quality coal. Due to inadequate investment, there are inadequate and/or mismatched transmission capacities, i.e., an insufficient grid.

Furthermore, China has a dual pricing system for coal, which favors big cities and major power consumers. Coal prices keep rising due to mine closings and transportation cost increases, but the state-mandated electric power price is static. In spite of the inequitable pricing of coal, the "system has largely succeeded in maintaining a virtually flat electricity tariff to China's industries and main cities."[11] Power shortages likely will continue until 2007, as it will take time to build additional capacity. Some predict an eventual glut due to overbuilding, the result of a characteristic command-economy overreaction. According to Philip Andrews-Speed, the current system "is unable to cope with China's growing energy needs. . . . Last year, a discontinuity between the pricing systems for coal and electric power caused a showdown between the two industries: the power companies were unwilling to pay the higher prices while their output prices were constrained. . . . The lack of a coherent policy for the electrical power sector will continue to be a major obstacle to investment."[12]

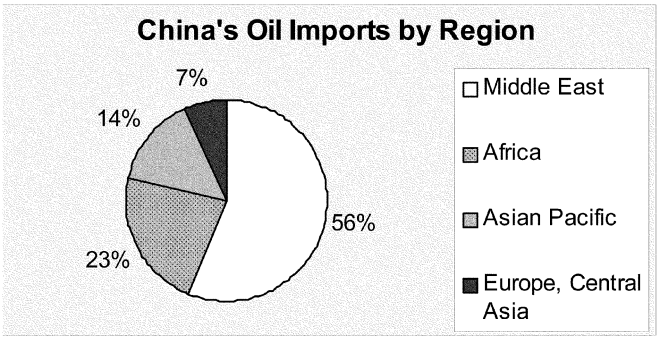
Oil

Oil accounts for twenty-five percent of China's energy use, and China needs to import increasing quantities to sustain growth. In the next decade, the number of vehicles on China's roads is expected to grow to one hundred million, about one half of today's U.S. combined car and truck total.[13] In mid-November 2003, China announced fuel economy standards for new cars and trucks. These fuel efficiency standards, stricter than ours, are a component of China's comprehensive energy security policy.[14]

China became a net oil importer in 1993 and has overtaken Japan to become the second largest petroleum consumer after the United States. Imports are expected to rise to 738 million barrels in 2004 against a total demand of 1.993 billion barrels per year. Domestic supply has begun to plateau at around 1.240 billion barrels a year.[15] EIA forecasts that China's oil imports will increase from today's roughly two million barrels per day to nearly eight

million in 2025, or to sixty percent of China's total oil consumption. The IEA expects China's oil imports to double to four million barrels per day by 2010 and reach ten million barrels per day by 2030.[16] Domestic oil production is flat.[17] (See appendix B, "China's Projected Oil Production v. Consumption, 1990–2020." "China is having an incredible influence on market flows, not just in Asia, but on a world-wide basis. . . . The whole center of gravity of the world energy market is changing."[18] This year and next, China is expected to account for one third of the increase in global oil demand in the $1 trillion a year global oil market.[19] Figure 6.2 presents China's oil imports from other regions in 2001.

Figure 6.2 China's Oil Imports by Region, 2001



Sources: FBIS document CPP20030425000288; China State Customs Administration 2001.

The Middle East, Africa, and Central Asia are the primary areas from which China seeks to meet its long-term needs for oil imports. China is also looking for additional sources of oil and gas in Indonesia, Burma, Venezuela, Peru, and Canada. China is reducing its dependence on Middle East imports, and Angola is now its number one oil supplier.[20] In the Middle East, China is pressing for access to reserves in Iran, the second largest exporter in the Organization of the Petroleum Exporting Countries (OPEC) after Saudi Arabia and hoping that any new Iraqi government will stand behind oil field development contracts it negotiated with China back in 1997. In September 2003, China's main oil company, China National Petroleum Company (CNPC), signed a cooperation protocol to develop Iran's Azadegan oil field. In the past year, Chinese state oil companies have also made investments or struck deals for future investment in Algeria, Azerbaijan, Ecuador, Kazakhstan, Myanmar, Thailand, and Venezuela. China probably will be unable to gain an upstream foothold in Saudi Arabian, Kuwaiti, and United Arab Emirate (UAE) fields, already controlled by western and Middle Eastern oil companies, however. Moreover, China's territorial disputes in and around the South China Sea may be related to its expectations of potential oil reserves and may shape its future efforts to become a more dominant regional power.

Throughout the past year, China and Japan have been competing over the construction of an oil pipeline from Angarsk, Russia, to the Pacific. China wants it to go through its northeast to Daqing, one thousand four hundred miles, at a cost of $2.5 billion. Japan

wants it to go through Russia to Nakhodka, two thousand three hundred miles, at an originally estimated cost of $5.0 billion to $7.5 billion. Further decisions had been put on hold since Mikhail Khodorkovsky, president of Yukos, the company backing the Daqing route, was arrested. On February 20, 2004, Russian Energy Minister Igor Yusufov announced that Russia is now studying the proposal to build the crude oil pipeline to Nakhodka. While China was concerned about a possible pullout by Russia from the agreement, *China Daily* pointed out that Yusufov's word is not final.[21] But it appears that Russia has finally decided to go the Nakhodka route, at an increased estimated cost of $10 billion due to the increased cost of pipe.[22] Figure 6.3 presents China's oil imports by country of origin in 1994, 1999, and 2001, by percent.

Figure 6.3 China's Oil Imports by Country of Origin, 1994, 1999, and 2001, by percent

Import Source Country	1994 Import Amount %	1999 Import Amount %	2001 Import Amount %
Iran	*	10.8	18.0
Saudi Arabia	*	6.8	14.6
Oman	27.3	13.7	13.5
Sudan	~	~	8.3
Angola	3.0	7.9	6.3
Vietnam	4.9	4.1	5.6
Indonesia	38.3	10.8	4.4
Yemen	10.2	11.3	3.8
Equatorial Guinea	~	2.2	3.6
Russia	~	*	2.9
Kuwait	~	*	2.4
Qatar	~	~	2.2
United Kingdom	~	6.0	*
Norway	~	5.5	*
Nigeria	~	3.7	*
Iraq	~	2.7	*
Australia	*	2.5	*

Legend:
* Denotes imports less than two percent
~ Denotes no imports
Source: China Customs Bureau.

China is the world's largest economy without a meaningful strategic petroleum reserve—seven to ten days, compared to Japan's one hundred. According to Kang Wu, an energy analyst with the

East-West Center in Hawaii and a witness at the Commission's October 30 hearing, China is addressing this problem with plans to expand its strategic reserve to fifty to fifty-five days worth of oil imports by 2005 and sixty-eight to seventy days by 2010.[23]

There is a clear distinction between U.S. and PRC approaches to securing oil supplies. Whereas the United States has shifted from an oil import strategy that was based upon controlling the oil at its source to one that is based on global market supply and pricing, the Chinese strategy is still focused on owning the import oil at the production point. According to James Caverly, of the U.S. Department of Energy, "[t]he U.S. strategic framework makes certain that plenty of oil is available in the world market so that the price will remain low and the economy will benefit." The Chinese policy is to own the barrel that they import "... to gain control of the oil at the source. Geopolitically, this could soon bring United States and Chinese energy interests into conflict. Both countries will be in the Persian Gulf for oil."[24] While China's direct investment into energy production could increase global energy supplies, its strategy of securing its own stake in an energy-exporting state, particularly in states of concern, does not appear on balance to contribute to the larger energy security picture for other energy-importing nations. According to EIA Administrator Caruso, in practice PRC equity investment has been comparatively small and not very rewarding.[25] To reduce its increasing dependence on the Middle East, China is diversifying and beginning to shift its energy activities toward the construction of pipelines as part of its comprehensive energy security policy.

On December 23, 2003, the State Council issued a white paper entitled *China's Policy on Mineral Resources*, which states that in order to implement former President Jiang Zemin's pledge to build a well-off society in an all-round way by 2020, China will depend mainly on the exploitation of its own mineral resources to guarantee the needs of its modernization program. The paper noted that "(a)bundant petroleum resources have been discovered in the western regions. Important discoveries have also been made in the Bohai Sea area. In the old oil fields, deeper formations will be exploited" to increase "verified oil reserves and maintain a rational rate of self-sufficiency in oil," reduce reliance upon spot trade, and encourage long-term supply contracts with foreign companies and imports from diversified sources.

The International Energy Agency (IEA), an autonomous body within the Organization for Economic Co-operation and Development (OECD), was established in November 1974 in the wake of the 1973–74 oil crisis. Energy security is its core activity. IEA member countries are committed to the maintenance and improvement of its emergency response systems. IEA gathers and analyzes statistics; administers a plan to guard member countries against the risk of a major disruption in oil supplies; coordinates national efforts to conserve energy and develop alternate energy sources as well as to limit pollution and energy-related climate change; disseminates information on the world energy market; and seeks to promote stable international trade in energy. The IEA oil security system includes maintenance by members of national emergency oil reserves and stockdraw plans, other national measures such as

demand restraint, fuel switching, and surge oil production; operation and coordination of national emergency organizations; testing response measures and training; mechanisms for industry advice and operational assistance; and a reallocation system. According to the IEA's *2002 World Energy Outlook*, IEA stocks were equivalent to 114 days of net imports. IEA importing member countries have a legal obligation to hold emergency oil reserves equivalent to at least ninety days of net imports. Since 1973, the largest oil supply disruption occurred in the 1978–79 Iranian revolution, resulting in a supply shortfall of 5.6 mb/d for six months. Today, the IEA member countries hold about 1.3 billion barrels of public oil stocks, and the IEA feels that its stockdraw potential is sufficient in magnitude and sustainability to cope with the largest historical supply disruption. The IEA cooperates with important nonmember oil-producing and -consuming countries including China.[26] Further involvement of China in the IEA's coordinated multilateral energy security activities could be conducive to the IEA's primary mission of energy security and end China's counter-productive spot market buying such as occurred prior to the Iraq invasion.

Natural Gas

Gas use currently constitutes only three percent of total PRC energy consumption; however, some ambitious gas infrastructure projects have already been launched to support rapid growth targets. Gas infrastructure development is expensive and time-consuming and requires the assurance of future markets and a clear government gas policy and regulatory framework. China's gas reserves were estimated at 53.3 trillion cubic feet in 2002.[27] The political reasons for shifting to natural gas are environmental and security related (i.e., dirty coal and imported oil). Furthermore, existing gas pipelines are underutilized, because China's cities do not have adequate distribution networks to bring the piped gas to individual users.[28] China's natural gas demand is projected to be 2.8 billion—3.4 billion cubic feet by 2010 and 6.4 billion cubic feet by 2020—with fifty-three percent for power generation, twenty-one percent for the chemical sector, and twenty-five percent for city fuel. To meet this demand, China National Offshore Oil Corporation (CNOOC) has signed a $12 billion, twenty-five year contract with Australia for purchase of liquefied natural gas (LNG) from Australia's North Shelf Project.[29] As discussed in Chapter 5, a PRC state-owned company and Iran have executed a $20 billion, twenty-five-year LNG contract.

PRC government plans call for increased gas consumption from the current three percent to eight to ten percent (from 34 billion cubic meters [bcm] to 200bcm) by 2020. The degree of increase depends on economic growth and infrastructure development assumptions. According to the State Development and Reform Commission's Energy Bureau, this goal will require a $26.5 billion investment in pipeline and terminal construction. Even then, domestic supplies will meet only sixty percent of the projected 200bcm demand. The rest will be imported by pipelines from Russia, Uzbekistan, Turkmenistan, and Kazakhstan, and as LNG primarily from Australia and Indonesia—in some cases involving equity investment—but also Iran, Russia, and Qatar. Several LNG

terminals are planned, meeting demand as well as supply security needs: unlike piped natural gas, LNG can be stored.[30] LNG is less vulnerable to terrorism than pipelines.

But, according to the IEA, cheap and abundant domestic coal remains the main competitor to increasing natural gas use, and the inadequate local gas distribution system is a major weakness in achieving the goal. According to the IEA's William Ramsay, the "key success factor is to secure paying customers, otherwise you run the risk of transporting the gas a long way for nothing."[31]

Nuclear Energy

Today, nuclear energy provides only 1.4 percent of China's electric power sector needs. China wants to build thirty-two reactors in addition to today's operational nine by 2020. Nuclear power is expected to account for eight percent of China's future electric power needs. The request for proposals to build the initial four reactors is expected to be issued shortly. Westinghouse and the French company Areva are considered to be the chief competitors, although the existing plants are of French, Canadian, Russian, Japanese, and Chinese designs. This competition is very significant, because China has indicated it wants a standardized design.[32] China's increased use of nuclear energy raises concerns about whether China has sufficient capacity to handle and safeguard spent nuclear fuel.

Joint R&D and Technological Assistance Opportunity Areas

As noted at the outset of the chapter, providing energy efficiency assistance to China may improve China's economic competitiveness, the subject of Chapter 1, but such programs may also work to reduce China's pressure on the world's energy (especially oil) supplies. China will continue to rely on coal as its main source of primary energy. If the PRC can use its coal more efficiently and cleanly, this increased efficiency will offset oil consumption, especially for generation of electric power. Because of coal shortages, the power sector has been increasingly relying on diesel generators. Improved coal production and power plant efficiency in China will reduce pressure on global energy supplies as well. If China can see a way out of dependency on the Middle East, it may be less motivated to enter into reciprocal relationships with states of concern in the Middle East that involve weapons and other nonmonetary concessions. Joint programs can be expected to provide opportunities for U.S. investment in the PRC energy sector (coal and nuclear-fired power plants) resulting in U.S. jobs and profits for U.S. power plant builders and spin-offs with efficiency and environmental benefits for the United States and the world.

Several types of energy technology assistance are currently feasible. The first is the Fischer-Tropsch technology or the coal gasification paraffin process that turns coal into diesel fuel. The costs of this process have dropped to around $30 per barrel. Some companies are currently producing diesel not from coal but from slag, or waste, to transport fuel within the existing infrastructure in an environmentally friendly way. Coal gasification permits sequestration of carbon dioxide. Also, coal gasification, together with the "combined cycle,"[33] produces gas competitive with natural gas. Another technology uses genetically modified biocatalysts to break down cel-

lulose into transportation fuel as ethanol by using straw waste from China's rice farms as feedstocks for transportation fuel. A third possibility is thermal depolymerization—a new waste-to-fuel process that is about to be demonstrated commercially in a ConAgra processing plant in Missouri.[34]

The objectives of the U.S. Department of Energy (DOE)—China Bilateral Science and Technology (S&T) Cooperation are to promote energy security interests between the world's two largest energy consumers, increase market opportunities for U.S. companies and technologies, deploy clean energy technologies, leverage U.S. S&T investments through mutually beneficial cooperation, and to positively influence China's nuclear nonproliferation, export controls, nuclear safety and health, and environmental and waste management. DOE has six S&T cooperation agreements/protocols and twelve annexes with China. Areas of collaboration include the following:

1. High Energy Physics Implementing Accord
2. Protocol on Nuclear Physics and Controlled Magnetic Fusion
3. Fossil Energy Protocol
4. Energy Efficiency and Renewable Energy Protocol
5. Peaceful Uses of Nuclear Technology
6. Protocol on the Exchange of Energy Information
7. Cooperation on the Beijing 2008 Green Olympics[35]

Further technological cooperation projects are on the horizon. PRC fossil fuel efficiency and pollution problems can be effectively addressed by U.S. "off-the-shelf" technologies. Several other potential target areas for technological assistance include coal mining practices efficiencies, coal washing, coal bed methane, new power plant thermal efficiency, and the addition of desulphurization equipment and low NOx burners and particulate emission control equipment on power plants. Several problems hinder such cooperation. From China's perspective, there must be a direct economic, not just environmental, benefit from technology transfer to give the project high priority—not uncommon in developing countries. Further, there exists the possibility of intellectual property rights violations, an otherwise high-risk investment environment, and the PRC's underlying desire to solve problems domestically.

Most of the U.S.-China bilateral cooperative programs in the energy sector are conducted under the framework of the 1979 S&T Agreement discussed in Chapter 7.

In September 2003, U.S. Energy Secretary Abraham signed a key nonproliferation assurances agreement with China. The agreement established a process for determining the necessity of government-to-government nonproliferation assurances in relation to certain nuclear technologies. Thus, the agreement opened the door for scientific cooperation in this field, beginning with the development of the Modular High Temperature Gas Pebble Bed Reactor.[36]

In June 2002, Hydrocarbon Technologies, Inc., (HTI) and China's largest coal-making company, Shenhua Group, signed a $2 billion contract under which HTI will provide technology license, process design, and technical services for construction of the direct coal liquefaction plant. With capability to produce fifty thousand barrels per day (eighteen million per year), this plant will be the second

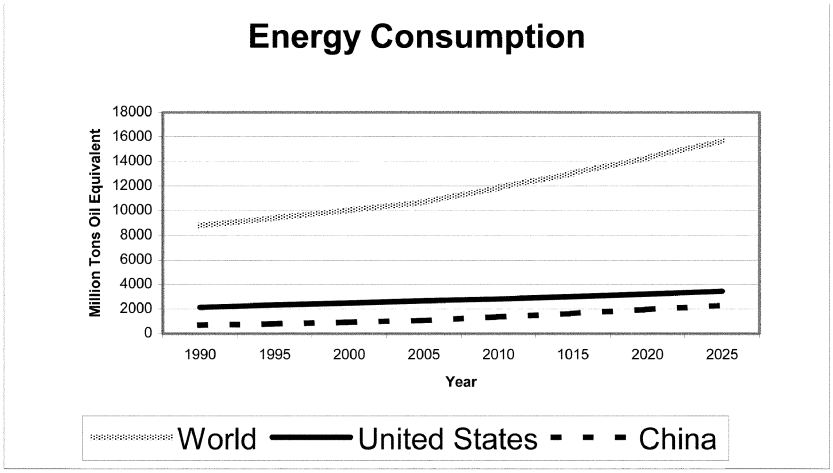
largest in the world after South Africa's Secunda plant. That plant has a capacity of twenty-five million barrels per year and was built in 1982. Construction began in 2003, and operation is to begin in 2005.

Global Energy Picture

Economic growth drives global energy demand. World GDP has grown at the annual rate of 3.1 percent, from $12.7 trillion in 1970 to $32.2 trillion in 2001, and is forecast to grow at the same rate, to $67.4 trillion in 2025. U.S. GDP is expected to grow at three percent per year to $19.3 trillion by 2025, and China's GDP is expected to grow at 6.2 percent, to $5.1 trillion in 2025.[37]

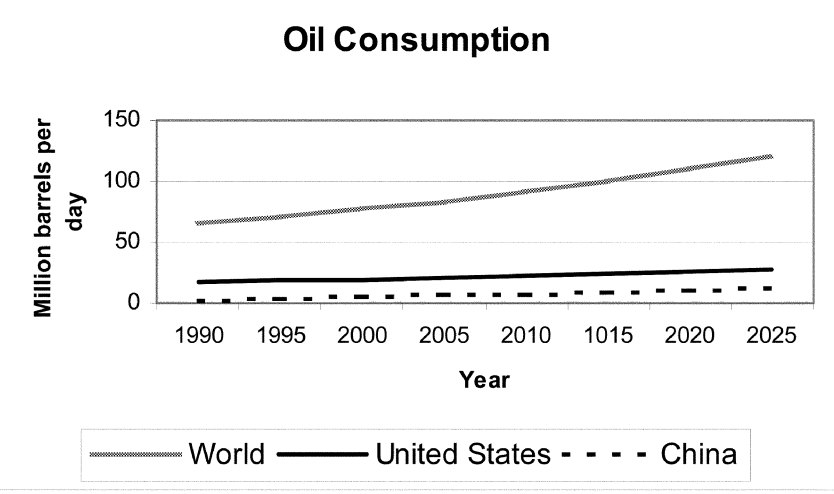
Global energy demand is projected to increase by fifty-eight percent by 2025, from 404 quadrillion British thermal units (BTUs) in 2001 to 640 quads in 2025.[38] See figures 6.4, 6.5, and 6.6 and appendix C, "China Energy Comparisons," for a more detailed view of future trends of China's energy consumption, energy intensity, and carbon intensity compared with the United States and the world total. Oil has been, and will remain, the foremost source of primary energy. World oil consumption is projected to increase from seventy-eight million barrels per day to 119 million barrels in 2025; sixty-one percent will be produced by OPEC and thirty-nine percent by non-OPEC countries. Natural gas is the fastest-growing source of primary energy and is projected to double and overtake coal use, increasing its share from twenty-three to twenty-eight percent. Coal use is projected to increase slowly at 1.5 percent per year, but its share of total global energy use will fall from twenty-four percent to twenty-two percent, with China and India accounting for seventy percent of the increase in coal use. Globally, coal is used primarily in electric power generation (sixty-four percent worldwide) and secondarily in key industries such as steel. According to EIA, "(o)ne exception is China, where coal continues to be the most widely used fuel in the country's rapidly growing industrial sector, reflecting China's abundant coal reserves and limited access to other sources of energy."[39] Globally, nuclear power as a source for electric power is expected to fall from sixteen percent in 2001 to twelve percent in 2025.[40] As a percent of total world energy, it will decrease from around seven percent to about five percent during the same period.[41] Global use of renewable energy sources is expected to increase gradually to around eight percent by 2025.[42] But in China, nuclear power utilization is expected to increase.[43]

Figure 6.4 Energy Consumption, 1990–2025



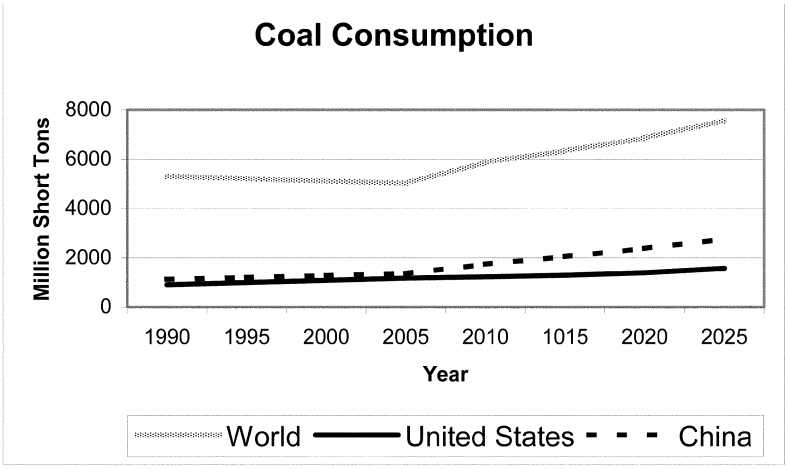
Source: Energy Information Administration, "International Energy Outlook, 2004."

Figure 6.5 Oil Consumption, 1990–2025



Source: Energy Information Administration, "International Energy Outlook, 2004."

Figure 6.6 Coal Consumption, 1990–2025



Source: Energy Information Administration, "International Energy Outlook, 2004."

World Oil Production and Supplies

The EIA's global oil resource base consists of three categories: remaining proven reserves (oil that has been discovered but not produced), reserve growth (increases in proven reserves that occur over time as oil fields are developed, produced, and improved technologically), and undiscovered resources (oil that remains to be found through new field exploration). Figure 6.7 presents these three categories with regard to China, the United States, OPEC and non-OPEC countries, and the world.

Figure 6.7 Oil as a Global Energy Resource

Country	Remaining Proven Reserves (billion barrels)	Expected Reserve Growth (billion barrels)	Undiscovered Resource Estimates (billion barrels)
China	18.3	19.6	14.6
United States	22.7	76.0	83.0
OPEC Countries	869.5	395.6	400.5
Non-OPEC Countries	396.3	334.5	538.4
World Total	1,265.8	730.1	938.9

Source: Energy Information Administration, "International Energy Outlook, 2004."

Canada's proven oil reserves have catapulted from 4.9 million barrels in 2002 to one hundred eighty million barrels in 2003 due to reclassification of Canada's oil sand resources as proven reserves as a result of dramatic reductions in production costs. Canada now has seventy-five percent of the world's oil sands, containing 1.7 trillion barrels of oil. Fifteen percent, 255 billion barrels, is recoverable. Today's production is seven hundred thousand bl/d (barrels

per day), and 2025 estimated production is 2.2 mb/d, of which one half will be consumed by the United States. The reason that the numbers are not higher is lack of transportation infrastructure.[44] Figure 6.8 presents global oil production and reserves by country.

Figure 6.8 Percentage of Global Oil Production and Reserves by Country

(Including adjustments due to recent Canadian developments in Canada's oil reserves)

Country	% World Production	% Reserves	Country	% World Production	% Reserves
North America	18.5	17.7	**Middle East**	29.2	56.5
United States	10.4	1.8	Saudi Arabia	11.6	21.5
Canada	3.3	14.8	Iran	4.8	7.4
Mexico	4.9	1.0	Iraq	2.9	9.3
Africa	11.1	7.6	Kuwait	2.7	8.0
Asia Pacific	10.6	3.2	United Arab Emirates	3.2	8.0
Latin America	8.8	8.1	**Europe**	9.1	1.6
Eurasia	12.5	6.4	**Other**	4.0	
Russia	6.8[45]				

Source: Cambridge Energy Research Associates, Accenture, and Sun Microsystems, *Global Oil Trends 2003*.

Technological innovation, such as Digital Oil Field of the Future, likely will make exploration and production more exact and targeted. This would change the oil supply landscape, as physical supplies that were previously too expensive to explore will become economically feasible, expanding the world oil reserves by 125 billion barrels in the next five to ten years.[46] The U.N. Institute for Training and Research Centre for Heavy Crude and Tar Sands estimates that the combined global amount of Canada's and Venezuela's recoverable reserves is equivalent to the total recoverable reserves of the Middle East. At present, heavy oil is only 3.5 percent of global oil production,[47] but, according to an industry study, bitumen and heavy oil could make up half of the world's energy supplies by 2050.[48]

There are differing views regarding future oil supplies. According to the optimistic view, voiced during the Commission's October 30, 2003, hearing, the production of cheap crude will peak around 2040, allowing plenty of time for development and transition to other fuels, and therefore a shortage of conventional oil is not a long-term energy security problem.[49]

According to other studies, however, global production of cheap crude could peak sooner—between 2010 and 2020.[50] There is rising skepticism among energy experts that Saudi Arabia may not be able to provide oil at levels previously estimated. An internal Saudi

Aramco plan estimates total production capacity in 2011 at 10.15 million barrels per day, whereas the U.S. Department of Energy projects that Saudi Arabia will produce 13.6 million barrels per day in 2010 and 19.5 in 2020. Oil executives and government officials in the United States and Saudi Arabia predict that Saudi capacity may stall near current levels, potentially creating a significant gap in global energy supply.[51]

According to R. James Woolsey, estimates of world conventional oil reserves vary "between a trillion and two trillion barrels, depending on what probabilities you assign and how optimistic or pessimistic you are" and "the fields on the average in the world outside the Persian Gulf either have already peaked or should peak within the next very few years."[52] Peaking is when half of estimated ultimately recoverable reserves have been extracted. This is a very important point for any oilfield. When this midpoint is reached, production costs tend to escalate rather sharply. Whether the world's oil supplies peak in 2010 or 2020 depends on whether the calculation is based on the one trillion or two trillion number. When global supplies peak, there will be (1) increasing oil market dominance by the Middle East, (2) increased extraction/production costs, and (3) concurrent substantial increase in demand from the growing economies of China and India.[53]

One reason for the differing estimates is the definition and use of the terms "reserves," meaning the known quantities of oil that can be readily commercially produced, and "resources," defined as theoretical estimates of total amounts that may exist and that cannot be extracted commercially with current technology. Another is that countries and companies often misrepresent the figures for political and commercial purposes. "Oil is money and . . . reserves are oil in the bank."[54]

In its most recent estimate, the IEA revised global oil demand upward by two hundred seventy thousand barrels per day to 78.3 mb/d, a 2.2 mb/d or almost three percent increase over last year, of which China's demand was revised upward by one hundred eighty thousand barrels to a record 6.14 mb/d.[55] China's surging demand growth, combined with its go-alone energy security policy, OPEC's production cutbacks, the IEA's reduction of the expected non-OPEC supply growth to less than 1.3 mb/d, and potential global supply instabilities will put increasing pressure on global energy supplies and prices, with resulting consequences for the U.S. economy.[56]

Geostrategic Implications

Assessment of the amount of oil reserves and the rate of extraction does not consider supply disruptions, such as the Arab oil embargoes of 1967, 1973, and 1979 and the more recent events in Iraq, Venezuela, and Nigeria. In a global crisis situation, China's lack of a meaningful strategic reserve and the absence of a true global safety net would put additional pressure on the market, not directly related to extraction capabilities.

According to some energy analysts, as its dependence on imported energy grows, China will become increasingly vulnerable to market disruptions. China considers the United States as its most likely potential adversary, with the capability to cut off energy sup-

plies. For this reason, it fears what it considers U.S. control of access to Middle East oil supplies. The U.S. military presence in the region contributes to this sense of insecurity. More specifically, according to Amy Myers Jaffe of the James A. Baker III Institute for Public Policy at Rice University in Houston, Texas, China is concerned that the United States will blockade either militarily or by diplomatic means China's access to oil if there were a military conflict over Taiwan, or the United States, having strong relationships with oil producers, will ask those producers to reduce supplies to China. China feels boxed in, and these perceptions drive China's policy.[57]

The IEA finds that China's oil policy has been to establish stable, long-term supply relationships "through reciprocal investment and non-oil trade. Its forays into Iran (with arms trade), Iraq and Sudan have raised eyebrows and concerns in other oil-importing capitals, notably Washington. The United States has energy security concerns as well, and fears that China's efforts may be destabilizing for the region as a whole." The IEA has also noted that "[r]ecently, China has tended to stress energy security more and diplomatic adventure less."[58]

Global oil demand has also skyrocketed, led by the United States and the PRC. China's growth has sparked economic recovery and higher oil demand in the rest of Asia. India, too, is an increasingly oil-dependent economy. Oil revenues are dollar denominated, motivating OPEC to keep supplies tight, and inventories are low. In addition, the United States has not yet recovered from the disruption in supply of crude and refined products from Venezuela last year, and there has been continued instability in Venezuela, Nigeria, and Indonesia. Royal Dutch Shell announced it was lowering by twenty percent its estimate of reserves, and there have been questions regarding the size of Saudi reserves.[59] Finally, this past March, OPEC announced a four percent cut in its oil output target, a move that is seen as confirming "an end of longstanding efforts to stabilize oil prices."[60] However, in a recent statement, Saudi oil minister Ali al-Naimi called for OPEC to raise its production ceiling by 1.5 million barrels per day.[61]

Some analysts believe that China's dependence on imported oil will bring the United States and the PRC closer as the result of common interests in Middle East stability. Others conclude that U.S. and PRC interests do not converge where oil is concerned, pointing out China's ties with oil-rich countries that are not on friendly terms with the United States.[62]

According to Philip Andrews-Speed, while the focus has been on external threats to China's energy security, "... the past year has shown that the real threats are domestic, rather than foreign. For more than twenty years, China has lacked a coherent energy policy. Energy strategies have been aggregated from the plans of individual energy industries. Coordination takes place only after the industry plans have already been drafted."[63]

According to Robert E. Ebel, "We are vulnerable to any event, anyplace, that affects the supply and demand of oil." In particular, the Middle East remains the world's low-cost producer and possessor of two-thirds of the global conventional oil supplies.[64] Meanwhile, non-OPEC resources are maturing, and OPEC market share

can only increase over the next two decades. Only by finding a viable alternative to oil will the consuming countries break their dangerous reliance on OPEC oil. Hydrogen power and bioethanol are two technologies that might provide an escape in a decade or two.[65]

RECOMMENDATIONS

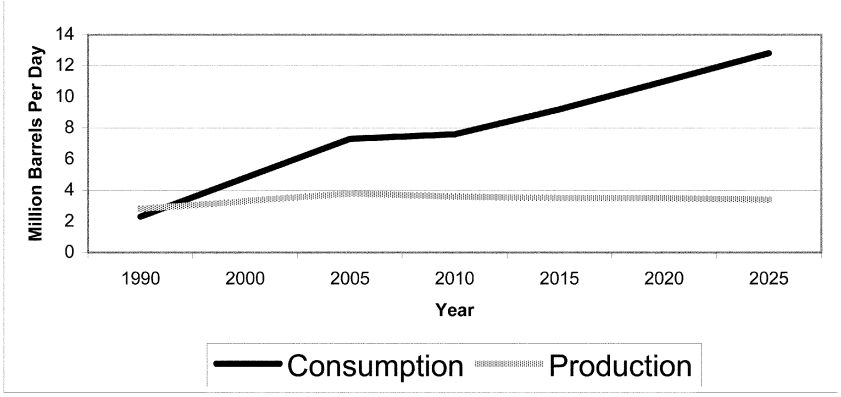
- The Commission recommends that Congress direct the secretaries of State and Energy to consult with the International Energy Agency with the objective of upgrading the current loose experience-sharing arrangement, whereby China engages in some limited exchanges with the organization, to a more structured arrangement whereby the PRC would be obligated to develop a meaningful strategic reserve, and coordinate release of stocks in supply disruption crises or speculator-driven price spikes.[66]
- The Commission recommends that Congress encourage work that increases bilateral cooperation in improving China's energy efficiency and environmental performance, such as further cooperation in Clean Coal Technology and waste-to-liquid-fuels programs, subject to any overriding concerns regarding technology transfers. Further, the Commission recommends that Congress direct the State and Energy departments, and the intelligence community, to conduct an annual review of China's international energy relationships and its energy practices during times of global energy crises to determine whether such U.S. assistance continues to be justified.
- The Commission recommends that the Commerce Department and USTR investigate whether China's dual pricing system for coal and any other energy sources constitutes a prohibited subsidy under the WTO and include this assessment in the Commerce/USTR report on subsidies recommended in Chapter 1.

Appendix A China's Energy Trends, 1985–2020

	1985	1990	1995	2001	2005	2010	2015	2020	Average Annual Percent Change 1985–2020
Energy Consumption				**(Quadrillion Btu)**					
Oil	4.0	4.9	7.0	10.2	11.3	13.4	15.8	19.2	4.6
Natural Gas	0.5	0.6	0.7	1.1	1.6	2.5	4.2	5.0	6.6
Coal	16.7	20.3	25.5	25.4	26.5	33.3	38.9	46.2	3.0
Nuclear	10.0	0.0	0.1	0.2	0.6	0.7	1.3	1.3	N/A
Renewables	1.0	1.3	1.9	2.8	3.2	4.6	5.2	5.9	5.3
Total	**22.2**	**27.0**	**35.2**	**39.7**	**43.2**	**54.4**	**65.5**	**77.6**	**3.6**
Oil (mbbd)	1.9	2.3	3.4	5.0	5.5	6.5	7.7	9.4	4.7
Natural Gas (tcf)	0.5	0.5	0.6	1.0	1.4	2.3	3.8	4.5	6.8
Coal (mst)	921	1,124	1,498	1,383	1,442	1,811	2,115	2,511	2.9
Nuclear (bkwh)	0	0	12	17	57	66	129	131	N/A
Renewables (quads)	1.0	1.3	1.9	2.8	3.2	4.6	5.2	5.9	5.3
Net Electricity Consumption (bkwh)	**364**	**551**	**883**	**1,312**	**1,545**	**1,966**	**2,428**	**2,986**	**6.2**
Energy Use for Electricity Generation				**(Quadrillion Btu)**					
Oil	0.8	0.7	0.6	0.7	0.8	0.9	1.1	1.3	1.5
Natural Gas	0.0	0.0	0.0	0.1	0.3	0.7	1.0	1.0	13.0
Coal	3.4	5.4	8.4	13.7	14.5	19.3	23.9	28.7	6.3
Nuclear	0.0	0.0	0.1	0.2	0.6	0.7	1.3	1.3	N/A
Renewables	1.0	1.3	1.9	2.8	3.2	4.6	5.2	5.9	5.3
Total	**5.1**	**7.4**	**11.1**	**17.4**	**19.4**	**26.2**	**32.5**	**38.3**	**5.9**
Carbon Dioxide Emissions				**(Million Metric Tons Carbon Equivalent)**					
Oil	76	94	132	175	194	229	271	330	4.3
Natural Gas	8	8	10	18	26	40	68	81	7.0
Coal	424	514	645	639	668	840	980	1,164	2.9
Total	**508**	**617**	**788**	**832**	**888**	**1,109**	**1,319**	**1,574**	**3.3**
Energy Production				*Note: EIA currently only projects oil supply.*					
Oil (mbbd)	2.5	2.8	3.0	3.2	3.5	3.6	3.5	3.5	1.0
Natural Gas (tcf)	0.5	0.5	0.6	1.1	N/A	N/A	N/A	N/A	—
Coal (mst)	962	1,190	1,537	1,459	N/A	N/A	N/A	N/A	—

Source: U.S.-China Economic and Security Review Commission, *Hearing on China's Energy Needs and Strategies*, testimony of Guy Caruso of EIA, October 30, 2003, p. 18.

Appendix B China's Projected Oil Production v. Consumption, 1990–2020



Source: International Energy Outlook, 2004.

Appendix C China Energy Comparisons, 1985–2020

	1985	1990	1995	2001	2005	2010	2015	2020	Average Annual Percent Change 1985–2020
Energy Consumption				**(Quadrillion Btu)**					
China	22.2	27.0	35.3	39.6	43.2	54.4	65.5	77.6	3.6
United States	76.7	84.6	91.5	97.0	103.2	113.3	121.9	130.1	1.5
World	311.1	348.4	368.7	404.1	433.3	480.6	531.7	583.0	1.8
Oil Consumption				**(Million Barrels per Day)**					
China	1.9	2.3	3.4	5.0	5.5	6.5	7.7	9.4	4.7
United States	15.7	17.0	17.7	19.6	20.5	23.0	25.2	27.1	1.6
World	60.1	66.1	70.0	77.1	81.1	89.7	98.8	108.2	1.7
Energy Consumption per Capita				**(Million Btu per Person)**					
China	20.7	23.4	28.9	30.8	32.7	39.8	46.4	53.7	2.8
United States	316.4	331.9	340.5	348.9	358.1	377.2	389.9	400.0	0.7
World	64.5	66.3	65.1	66.0	67.4	70.5	73.9	77.0	0.5
Energy Intensity				**(Thousand Btu per 1997 U.S. Dollar of GDP)**					
China	75.9	63.2	46.9	33.0	27.0	24.8	22.2	19.7	−3.8
United States	13.2	12.4	11.9	10.3	9.8	9.1	8.4	7.8	−1.5
World	15.1	14.3	13.7	12.5	11.9	11.2	10.6	10.0	−1.2
Carbon Intensity				**(Metric Tons Carbon Equivalent per 1997 U.S. Dollar of GDP)**					
China	1,736	1,445	1,047	693	555	506	447	400	−4.1
United States	213	198	185	166	154	144	134	124	−1.5
World	258	241	223	202	191	180	170	161	−1.3

Source: U.S.-China Economic and Security Review Commission, *Hearing on China's Energy Needs and Strategies*, testimony of Guy Caruso of EIA, October 30, 2003, p. 19.

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